KNOWLEDGE
AN ILLUSTRATED
MAGAZINE OF SCIENCE
PLAINLY WORDED—EXACTLY DESCRIBED

LONDON: FRIDAY, JULY 27, 1883.

CONTENTS OF No. 91.

	PAGE
How to Get Strong: Reducing Fat	49
The Birth and Growth of Myth. XII. By Edward Clodd	50
Spots on the Sun. By R. A. Proctor	51
Chemistry of the Cereals. II. By William Jago, F.C.S.	52
The Great Pyramid	53
Principles of Dress Reform. By E. M. King	54
The Moon in a Three-Inch Telescope (*Illus.*) By F.R.A.S.	56
Sun-Views of the Earth. (*Illus.*) By R. A. Proctor	57
Flight of a Missile	58
Editorial Gossip	59
Cholera (Preventive)	60
Correspondence: Geometrical and Real Perspective—Skyers—Dress Reform—Short Answers to Letters Received, &c.	60
Our Mathematical Column: Geometrical Problems	62
Our Chess Column	63

HOW TO GET STRONG.

REDUCING FAT.

(*Continued from page* 35.)

WE come next to the consideration of those methods of reducing fat which depend on quantity and quality of food.

So much attention has been directed of late to special forms of diet for the reduction of fat, that the comparatively less pleasant but not less effective method of diminishing the quantity of food taken, seems in danger of escaping due attention. In the system—really a very old one—with which Mr. Banting's name has been associated, the question of quantity is scarcely considered at all. Many meals may be taken each day, and at each meal much solid and liquid food, so long as certain prohibited articles are not touched. It is the same with other dietary systems. Now, there can be very little doubt that such systems have in them something of the mischievous character of medicinal methods. They depend in part for their action in reducing fat on the disturbance which they cause the troubled body. The absolute absence of certain articles of food to which we have been long accustomed causes something like a shock to the system, and through the distress caused by this shock there comes a sort of drain on the body as certainly as when we take exercise, but not as advantageously. Diminishing the quantity of food, both solid and liquid, taken daily, is at once safer and better. We may either reduce the number of meals, or the quantity taken at each, or effect the reduction in both ways, as may best suit the constitution. For most, the third system will be found to act best. One who has been accustomed to four meals a day may take three, without harm from the change. Where two cups of tea or coffee have been taken, and two glasses of water or of other liquids at a meal, a single cup and a single glass may be taken, the change being scarcely noticed at all. The solid food may be diminished at each meal by the omission of that last slice, or serving, or course, as the case may be, which changes satisfaction into repletion. In a day or two the change will have become a habit, and no inconvenience will be felt. I do not lay down, be it understood, the rules, When eating, leave off hungry, When drinking, leave off thirsty. There is a good deal of sound sense in what Charles Lamb said about these rules—that one might as well say, When washing to leave off dirty. But there can be no doubt that most of us continue both to eat and to drink, at meals, after the appetite is really satisfied.

The same carelessness—for the fault arises more from carelessness than from greediness—causes us to eat between meals, a most mischievous habit for all, except those few whose constitutions require that they should eat little and often.

Any one who pays attention to the matter for a few days, or until habits of sensible eating and drinking have been established, will be surprised to find how much of his daily supply has been altogether unnecessary, and can therefore be dispensed with. The extra meal, the extra platefuls and glassfuls at each meal, and the mischievous snacks between meals, which most of us take, would suffice for the whole day's food of a moderately abstemious man. The wonder is that more of us are not overweighted with fat. But Nature benevolently gives to most a power of disposing of more than we ought to take—though the power is used at the expense of the working energies. Those who have not the power are those who when they take more food than is good for them became overweighted with fat—not wholly the product of the extra food, but partly (and chiefly) resulting from the extra work put on the bodily organs by the unduly large supplies taken into the system. For fat is a proof among other things that the forces of the body have been overtaxed in such ways that the digestive organs, the circulation, the respiration, the excretory organs, have been unable to do their fair share of work.

Yet undoubtedly great good may be done by attending to the quality as well as to the quantity of the food. Those articles of food which certain mischievous and rather dangerous fat-reducing systems would dispense with altogether may most advantageously be reduced, and there are some articles of food which persons of corpulent tendency may altogether discard. Bantingism excludes beer, butter and sugar, bread, potatoes, and milk. Of these, beer alone should be absolutely excluded. Butter and sugar should be taken in very small quantities. Of bread, potatoes, and milk, the fat should take about half as much as they generally do. To many it is beneficial to go almost entirely without butter, milk, and saccharine food. The sudden disappearance of headaches, especially of the so-called bilious headaches, shows the benefit of the change. But it will not suit all. Bread and potatoes can be diminished in amount without any particular trouble. But potatoes should not be altogether excluded. They form an important item of food as food is taken in Europe and America. By taking one half of the quantity which has been usual with him, the fat man gets all the good he needs from potatoes, and avoids the mischief they have been doing him by adding to his fat. Taking tea without milk or sugar is pleasant enough, though the tea should then be weakened and cooled by the addition of a little cold water instead of milk. Coffee and cocoa without milk or sugar are medicine to most. But coffee and cocoa are not good for the corpulent, though they act mischievously in an indirect way only. All such wines as port, sherry, madeira, champagne, and sweet wines generally, are unsuitable for the obese. Claret is better; whiskey and water better still. But the less of any alcoholic stimulant taken the better. Best to take none. The control of the appetite, especially for flesh food, is much greater when no alcohol at all is taken into the

system. If the health suffers from going entirely without alcohol, then one tumbler of whiskey and water—at least three parts water, *per diem*—is all that should be taken. Even that should be reduced as the health improves.

Any one who, being corpulent, is unwilling to go without port, sherry, and other heavy wines, or without beer, or without undue draughts of spirits and water, need not read these articles. He must be one who has definitely decided that health and strength, lightness of spirits, as well as lightness of body, are not worth even a small sacrifice. He is as one who, knowing a cup contains poison ruinous to body and mind, drains it because the poison is diluted in a sweetly-tasted liquor.

I am aware, let me note in passing, that the advocates of special systems of diet for reducing fat, insist on a rigid adherence to certain rules, a rigid abstinence from certain articles of diet. They are right according to their lights. If we are to trust to Bantingism alone, for instance, to reduce fat, we must be rigid followers of the Banting system, we must take no potatoes and no bread, no beer and no milk, no butter and no sugar. And so of other systems. But if we are following a broader system, or rather a system of systems, we may take the good from each, and reject the bad.

Just here I may introduce a most important point, not noticed as yet, so far as I know, in any system for reducing corpulence. It is related closely to the question of quantity in food; but it is also related to that particular point on which, as I have said above, the development of corpulence in great part depends—the insufficient action of organs because of overwork. I refer to the proper mastication of food. We most of us eat a great deal too quickly, gulping down mouthfuls which have not received half or even a quarter of the amount of mastication due to them. From this gross fault two serious evils follow. We eat much more food than we should if we masticated all we ate properly, and the food we eat does us much less good than the right amount would do if properly masticated. We throw on the stomach much extra work, besides leaving some work undone which the stomach was never meant to do and is not competent to do. The overburdened stomach, consequently, leaves a part of its own work undone, so that the mischief is passed on to other organs, and the whole system is thrown out of gear. Let it be remembered as we eat that the teeth and the salivary glands have special work to do which they leave undone if we bolt our food. By making the jaws do their proper work, we make a smaller quantity of food supply our wants, and we send that smaller quantity to the stomach in a fit state for the stomach to work properly upon it. Hence a considerable saving of energy, and a corresponding reduction of those waste products which result in the formation of fat.

A lesser mistake, but still a noteworthy one, is to gulp down great draughts of liquid food, instead of quietly imbibing suitable quantities.

(To be continued.)

THE BIRTH AND GROWTH OF MYTH.

By Edward Clodd.

XII.

THE closing remarks in my last paper made reference to the terribly real form which belief in transformation assumed in the Middle Ages.

If wolves abounded, much more did the were-wolf abound. According to Olaus Magnus, the sufferings which the inhabitants of Prussia and neighbouring nations endured from wolves were trivial compared with the ravages wrought by men turned into wolves. On the feast of the Nativity, these monsters were said to assemble and then disperse in companies to kill and plunder. Attacking lonely houses, they devoured all the human beings and every other animal found therein. "They burst into the beer-cellars and there they empty the tuns of beer or mead, and pile up the empty casks one above another in the middle of the cellar, thus showing their difference from natural wolves." In Scandinavia it was believed that some men had a second skin, out of which they could slip and appear in the shape of a beast. Perhaps the phrase "to jump out of one's skin" is a relic of this notion. The Romans believed that the were-wolf simply effected the change by turning his skin inside out, hence the term "versipellis," or "skin-changer." So in mediæval times it was said that the wolf's skin was under the human, and the unhappy suspects were hacked and tortured for signs of such hairy growth. Sometimes the change was induced, it is said, by putting on a girdle of human skin round the waist; sometimes by the use of magical ointment. Whatever the animal whose shape a man took could do, that he could do, plus such power as he possessed in virtue of his manhood or acquired by sorcery, his eyes remaining as the only features by which he could be recognised. If he was not changed himself, some charm was wrought on the eyes of onlookers whereby they could see him only in the shape which he was supposed to assume. The genuine monomaniacs aided such an illusion. The poor demented one who conceived himself a dog or a wolf, who barked, and snapped, and foamed at the mouth, and bit savagely at the flesh of others, was soon clothed by a terror-stricken fancy in the skin of either brute, and believed to have the canine or lupine appetite in addition to his human cunning. The imagination thus projects in visible form the spectres of its creation; the eye in this, as in so much else, sees the thing for which it looks. Some solid foundation for the belief would, however, exist in the custom among warriors of dressing themselves in the skins of beasts to add to their ferocious appearance. And it was amidst such that the remarkable form of mania in Northern Europe known as the Berserkr rage ("bear-sark" or "bear-skin" wearer) arose. Working themselves by the aid of strong drink or drugs and contagious excitement into a frenzy, these freebooters of the Northland sallied forth to break the backbones and cleave the skulls of quiet folk and unwary travellers. As with flashing eyes and foaming mouth they yelled and danced, seemingly endowed with magic power to resist assault by sword or club, they aroused in the hysterically disposed a like madness, which led to terrible crimes, and which died away only as the killing of one's fellows became less the business of life.

During the fifteenth and sixteenth centuries, the belief in men-beasts reached its maximum, and met with no tender treatment at the hands of a Church whose Founder had manifested such soothing pity towards the "possessed" of Galilee and Judæa. That Church had a cut-and-dried explanation of the whole thing, and applied a sharp and pitiless remedy. If the devil, with countless myrmidons at his command, was "going to and fro in the earth, and walking up and down in it," what limit could be put to his ingenuity and arts? Could he not as easily change a man into a wolf or a bear, as a woman into a cat; and had not each secured this by a compact with him, the foe of God and His Church? The evidence in support of the one was as clear and cogent as in support of the other; hence were-wolf hunting and burning became as Christian a duty and as paying a profession as witch-smelling and

torturing. Any cruelty was justified by its perpetrators when the object in view was the vindication of the majesty of God; and not until the advancing intelligence of men recoiled against the popular explanations of witchcraft and lycanthropy were the laws against both repealed.

Those explanations were survivals of savage mental philosophy blended with a crude theology. To the savage, all diseases are the work of evil spirits. If a man hurts himself against a stone, the demon in the stone is the cause. If the man falls suddenly ill, writhes or shrieks in his pain, the spirit which has smuggled itself in with the food or the drink or the breath is twisting or tearing him; if he has a fit, the spirit has flung him; if he is in the frenzy of hysteria, the spirit within him is laughing in fiendish glee. And when the man suddenly loses his reason, goes, as people say, "out of his mind," acts and looks no longer like his former self, still more does this seem the work of an evil agent within him. It is kindred with the old belief that the sickly and ugly infant had been left in the cradle by the witch in place of the child which she had stolen before its baptism.* And the thing to do is to find some mode of conjuring or frightening or forcing the demon out of the man, just as it became a sacred duty to watch over the newly-born until the sign of the Cross had been made on its forehead, and the regenerating water sprinkled over it.

"Presbyter is but old priest writ large." And the theory of demoniacal agency was but the savage theory in a more elaborate guise. To theologians and jurists it was a sufficing explanation; it fitted in with the current notions of the government of the universe, and there was no need to frame any other. Body and mind were to them as separate entities, as they are to the savage and the ignorant. Each regarded the soul as independent of the body, and framed his theories of occasional absence therefrom accordingly. But science has taught us to know ourselves not as dual, but as one. She lays her finger on the subtle, intricate framework of man's nervous system, and finds in the derangement of this the secret of those delusions and illusions which have been so prolific in agony and suffering. She makes clear how the yielding to morbid tendencies can still foster delusions, which, if no longer the subject of pains and penalties in the body politic, are themselves ministers of vengeance in the body where they arise. And in the recognition of a fundamental unity between the physical and the mental, in the healthy working of the one as dependent on the wholesome care of the other, she finds not only the remedy against mental derangement and all forms of harmful excitement, but also the prevention which is better an cure.

THE LUMINOSITY OF HEATED GASES.—Dr. Werner Siemens has recently demonstrated, by means of his regenerative furnace, that highly heated gases do not emit light. The furnace employed was that of his brother, the glass manufacturer of Dresden, which gives a temperature of 1,500 deg. to 2,000 deg. Centigrade. The interior of the furnace was watched through sight-holes, and not the least light met the eye from the highly-heated air of the furnace. It therefore appears that all light from h[illegible]ted gas must come, not from the gas, but some solid rad[illegible]ting impurity. Observations with a thermo-pile also seem to show that no heat either is radiated by pure gases at a high temperature.—*Engineering.*

---

* Spenser says:—

"Such, men do *changelings* call, so changed by fairies' theft."

SPOTS ON THE SUN.

BY RICHARD A. PROCTOR.

JUST now, when there are many spots on the sun, when new spots are continually forming, and when, in fine, that state of disturbance which is indicated by solar spots seems to be nearly at its height, it may be interesting to consider what the solar spots probably are, how they are generated, how they affect surrounding parts of the sun's surface, and how, after passing through the various stages of their existence, they come eventually to disappear. The inquiry is one of much difficulty, for the phenomena presented by spots are very complex and perplexing. We shall have to look at the subject from every available point of view, to see whether, by combining together all that is known either about the spots themselves or about phenomena related to them, we can determine their real nature.

In the first place, it will be well to consider what lies, probably, underneath the visible solar surface. We can then pass to the surface itself, thence to what lies outside that surface, until we reach the limits beyond which, so far as can be judged, we are not likely to obtain any information bearing directly on the solar spots.

Now, it is rather singular that the first direct information obtained by man respecting the sun's interior should have been derived from the study of the earth's crust beneath his feet.

Yet that has, in effect, been the case. The earth's crust tells us in unmistakable terms of tens of millions of years during which the sun has been at work pouring his rays of light and heat upon the earth as now—it may be in greater, it may be in smaller amount at one time or at another, but doing—which is all we need consider—an amount of sun-work corresponding to tens of millions of years' work at his present rate of emission of light-waves and heat-waves. Dr. Croll tells us, and Sir Charles Lyell adopted the statement as within the truth, that the earth's crust thus speaks unmistakably of at least one hundred millions of years of sun-work.

Now, the source of the solar light and heat is to be found in gravitation—that mysterious force which explained the mystery of the planetary movements, but presents in itself a far greater mystery. It explains also the mystery of light and heat which but for gravity would never have existed. The gathering-in of the sun's mass to its present volume, whatever that volume may be, generated the light and heat which the sun has emitted in the past, and the same process continuing will generate as the sun's volume continually diminishes the light and heat which doubtless he will continue to emit for many millions of years yet to come.

But if we measure the sun's volume, his mass being known, by the length of time during which he has been at work as at present, we find that, however vast we suppose the region of space to be throughout which his mass was formerly distributed, he must—judging from the work he has already done—have a volume very much less than he appears to have. For if he had gathered in his mass from a region of space practically infinite, until it was uniformly distributed throughout a volume such as the solar photosphere encloses, the heat resulting from this process of formation would not be equivalent to more than some twenty millions of years' supply of heat at the present rate of emission. But the earth alone tells us of at least one hundred millions of years of such emission of heat. Now, I think we may safely set aside Dr. Croll's explanation that the sun's heat might in part have been derived from the

collision of bodies travelling already through interstellar space with enormous velocity; for when we rightly apprehend the vastness of such space we see that collisions of those bodies could no more occur with the necessary frequency than the bullets fired by two widely-scattered bodies of skirmishers could be continually encountering in mid-space. We seem forced to the conclusion that the work of solar condensation has gone on much farther than it seems to have done—in other words, that the sun's real globe is very much smaller than that globe, bounded by the photosphere, which is actually seen by us.

According to this view, the real surface of the sun would lie tens, possibly hundreds, of thousands of miles below the photosphere—far below even the lowest of those lower levels disclosed in the larger sun-spots.

That this view is correct is shown in other ways. If we consider how the sun-spots shift in relative position, through what is called their proper motion, we cannot but infer that the cloud-laden region in which they are formed lies very far from the real surface of the sun. The spots are limited, as every reader no doubt knows, to two zones of the solar photosphere corresponding to the sub-tropical and temperate zones on the surface of the earth. Those which lie nearest to the equator indicate a rate of rotation, in the equatorial zone of the visible surface, carrying it round once in about twenty-four days. Those which lie farthest from the equator indicate a rotation period for these parts of the spot zones, carrying them round once in about twenty-four days. Now, if we assign to the equatorial zone an area equal to a tenth of the sun's, we have a surface exceeding the earth's 1,200 times. To each of the zones of slowest motion (leaving the Polar regions out of consideration altogether) we may assign half this area, or to the two combined the same area. The depth of the cloud-laden region in which the spots are found averages certainly not less than 8,000 miles—or say a diameter of this earth. The volume, then, of the equatorial zone of cloud-laden matter, which rotates once in twenty-four days, is certainly not less than 2,300 times the volume of the earth.* This also is the sum of the volumes of the two spot zones farthest from the equator, which rotate once in twenty-eight days. If these regions were of the same mean density as the sun, or about one-fourth the earth's, then the mass of the equatorial region would be about 600 times the mass of the earth, or nearly twice the mass of the giant planet Jupiter—and each of the zones remotest from the equator would nearly equal Jupiter in mass. Now, it is utterly impossible that such masses if forming part of a continuous atmospheric cloud-laden region, and not very far indeed from the surface of any solid, liquid, or highly-compressed vaporous nucleus the sun may have, should be free to travel round at rates so different, that the equatorial region is carried round seven times while the two farther spot zones are carried round only six times, the former gaining one rotation—a circuit of two million miles—on the latter in 168 days, or nearly 500 miles per hour. Frictional resistance would undoubtedly coerce the various zones of the sun's surface to the same rotation rate. The cloud-laden region in which the spots appear must, therefore, be very much rarer than the sun's real globe, and the sun's real surface must lie far below the visible surface.

* It may be divided into 1,200 cubes (approximately enough) each a terrestrial diameter in the edge, each therefore exceeding the earth in volume in the same degree that a cube exceeds the inclosed sphere, or as 6 exceeds π. Putting π at 22/7, this gives the ratio, 21 to 11, in which 1,200 must be increased, giving 2,300 approximately.

There is another proof of the same important fact. It has been shown by Professor George Darwin that if the central parts of the sun were not very much denser than the rest, the sun's globe would be measurably compressed at the Poles. Now there is nothing more certain than that no such compression can be recognised. The meridional observations of the sun at all the great national observatories are now to be counted by hundreds of thousands, and they are all (practically) measurements of the sun's disc. If there were measureable compression, it would be recognised among this vast collection of measurements. But they agree in showing no trace of measurable compression. It follows that the sun's central portion is much more condensed than parts near his visible surface, a result agreeing with what we have already inferred from two lines of reasoning, each nearly amounting to a demonstration.

We conclude, then, that the real surface, where in all probability the disturbances arise to which sun-spots are due, lies tens of thousands, possibly hundreds of thousands, below the visible surface, where the effects of those disturbances are recognised.

(To be continued.)

CHEMISTRY OF THE CEREALS.

By WILLIAM JAGO, F.C.S.

No. II.

SEVERAL of the constituents of the various grains with whose chemistry we are now dealing are so much alike that it is difficult to determine whether it is better to first finish what we have to say about one of these bodies and then go on to the others, or to commence by giving an outline of the properties of the whole, and subsequently deal with them in detail. Thus starch, cellulose, and the gum of the various cereals are identical in chemical composition, and in many respects are most closely allied to one another. It will probably render our work simpler if we at any rate study these three bodies together. Our last article will have made the reader acquainted with the general properties and appearance of starch; we would now direct his attention to the next member of our present group—viz., cellulose. The percentage of this body present in grains varies from 1·0 in oats to 14·9 in maize. A passing reference was made to it in our last paper, where it was stated that the outer envelope of the starch granules consisted of starch cellulose. The function of this body in plants is somewhat analogous to those of the skeleton and connective tissue in animals. Not only are the envelopes of the various cells of the plant composed of it, but also woody fibre and the more solid framework of plants consist of this compound. In physical properties cellulose differs widely: the pith of elder, linen, cotton wool, and some of the specially prepared paper used by the chemist for filtering purposes are nearly pure forms of cellulose. On the other hand, it occurs in an approximately pure state in the "tagua-nut," a substance so hard as to be capable of being turned in a lathe and having every appearance of ivory.

Cellulose, like starch, is represented by the chemical formula $C_6H_{10}O_5$, and is very probably derived in the plant from starch. One of the greatest wonders of organic chemistry is this fact of there being many substances of widely different appearance and properties, and yet of the same formula. Cellulose and starch are two cases in point, and to these we may add a third in dextrin, or "British

gum." Here, then, are three bodies, in many respects widely different from each other, and yet apparently alike from a chemical point of view. Supposing they were subjected to analysis, the result in each case would be carbon 44·45, hydrogen 6·17, and oxygen 49·38 per cent.; from these results the chemist would for each calculate as the simplest formula that just given above. In many cases he can further state with certainty that the molecule or ultimate group of atoms of each compound contains only the number of atoms represented by this simple formula; but in other instances he finds with equal certainty that the formula must be doubled. To make this clear by an example, the calculated formula of oxalic acid is HCO_2; other considerations, however, leave no doubt that the molecule actually contains $H_2C_2O_4$. We are here presuming that it is self-evident that, whichever be the formula, the percentage composition would be identical. It is not so easy to say with starch and these other bodies whether their formulæ are multiples or not of that above given. It is very probable that they are such multiples.

This much we know, that there are not only widely different chemical compounds whose formulæ only differ by being multiples of each other, but there are also others whose formulæ are actually identical, notwithstanding the very opposite characters they may present. In endeavouring to trace out the cause of this we must look to some different arrangement of the atoms within the molecule. The chemical elements and the chemical compounds may be aptly compared to the letters and words of a language; just as out of twenty-six letters, millions of word combinations are possible, so with our few chemical elements an infinity of chemical compounds may be produced. We know, further, that out of the same letters, differently arranged, we may form several words; thus the letters a, r, t give us respectively the words, art, rat, and tar; so in a similar manner may we suppose that different groupings of the atoms within a molecule may yield a variety of chemical compounds. Modern chemical research has gone a step further than this, and in many instances tells us exactly how the molecules are grouped together in the compound, and what the difference in grouping is that causes two bodies of similar percentage composition to vary so much in character.

Cellulose is white, tasteless, and insoluble in water; it may, however, be dissolved by a solution of copper oxide in ammonia, and can again be precipitated by the addition of hydrochloric acid. Starch and cellulose may be readily distinguished from each other by the addition of iodine; the latter compound remains colourless, or, at most, is stained slightly yellow. Starch, on the contrary, becomes an intense blue, so dark with much iodine as to appear black. This test is a most important one for starch, and may frequently be used in every day life for its recognition. It may be employed in the following manner:—Make a dilute solution of iodine in methylated spirits, or dilute the pharmaceutical tincture of iodine with spirits, until of a deep sherry tint; the re-agent is now ready for use. Make a solution of starch and add the iodine solution, notice the intense blue colour produced; on boiling the liquid the colour vanishes, but reappears on cooling. This test may be used for determining which are the starch-cells in microscopic sections of wood, &c., for on moistening the specimen with a very dilute iodine solution, the starch granules become blue. The uses of cellulose in the forms of cotton, linen, and paper are familiar to all.

Let us in the next place see what relation starch and cellulose bear to the gummy matter of the cereals. In our series of analyses, quoted in the former article, gum and sugar are classed together. The amount present varies from 1·6 in rice to 11·3 per cent. in rye; wheat is intermediate, with a percentage of 3·8. It has been already stated that this particular form of gum also has the formula $C_6H_5O_{10}$. From its powerful action on polarised light, it has received the name of "dextrin." The optical behaviour of dextrin and its allied bodies will furnish ample subject-matter for a separate article of the series. Starch and cellulose, if subjected to heat, become altered in character. This is more particularly seen with starch. By heating starch or flour to a temperature of about 150° C., it is found to undergo a slow change; it darkens in colour and acquires the odour of highly-baked bread. On now treating with water, a substance is dissolved out, which possesses all the most important properties of gum arabic; on evaporation, we have dextrin remaining as an uncrystallisable, solid, and translucent body. Dextrin is applied to a variety of useful purposes, among others the stiffening of calicoes, in which instance it is used as a substitute for its allied compound, cotton cellulose. Notwithstanding the intimate relationship of these two bodies, the substitution of dextrin is not altogether to be recommended, for although the material may look well in the hands of the shopman, the soluble dextrin, after the first washing, manages to avoid taking its share of the fair wear and tear of the article. Dextrin is also used for producing the adhesive layer on the back of postage-stamps. It is said to have been first discovered at the burning of a starch manufactory. One of the firemen, worn out by the exertions of extinguishing the fire, lay down in his garments, wetted by the water that had drained from the heated starch, and awoke to find himself firmly glued down to his resting-place. The production of dextrin, from starch by heat, was thus first noticed, and gave rise to its further manufacture. Should this account be the true one, many readers may see an analogy to the Chinese discovery of roast pork, by the accidental burning of a pig-stye; while rumour has it that the Chinese for some time burnt a pig-stye whenever they wanted roast pork—it is *not* the custom of English manufacturers to burn starch factories for the purpose of maintaining the supply of dextrin. [Charles Lamb, in his famous essay on Roast Pork, says a *house* was burnt to supply roast pork in the early stages of men's faith in that edible. I may note also that the account given in Dublin of the origin of the manufacture of the postal gum differs considerably from that given above. A whiskey store, not a starch manufactory, appears, and the national potato (introduced, as is well known, by St. Patrick, when he came over from his native city Glasgow for the purpose of driving out snakes from Ireland) plays an important part in the story.—R. P.]

THE GREAT PYRAMID.

MISS A. B. EDWARDS AND MR. R. A. PROCTOR.

[I have received the following letter from Miss A. B. Edwards, with permission to publish, of which I gladly avail myself.]

YOU have lately replied in the pages of KNOWLEDGE to certain correspondents who have reminded you that Egyptologists in general regard the Great Pyramid as a tomb only. I am, as you know, one of that number; but I, nevertheless, gladly take this opportunity of repeating that some of your views as to the astronomical purposes fulfilled at certain stages of its erection, seem to me not only sound and probable, but proved beyond further question. Your theory of the use and purpose of the water-

chamber, and of the ascending and descending passages, as tubes through which to obtain the reflection of the rays of Draconis, offers the only rational explanation of these parts of the structure with which I am acquainted; and your exposition of the purpose of the great gallery—which, as it now exists in the heart of the structure, ending against a dead wall, is entirely without object or use—appears to me absolutely irrefragible.

That the Great Pyramid was, in even a secondary sense, erected *in order* to obtain an astronomical platform and an observing tube, is what I cannot subscribe to; but given that the Pharaoh built his monster tomb during his lifetime, I can fully admit the likelihood of its having been made use of, during its progress, for purposes of astronomical or astrological observation.

AMELIA B. EDWARDS.

[I think my correspondents referred chiefly to remarks by some continental Egyptologists; but as Miss Edwards had expressed the same views in her very kindly notice of my book on the Great Pyramid, it is probable that several of them referred to her known views on the subject. It appears to me that most Egyptologists fail to estimate the significance of the astronomical relations involved in the Pyramids, and especially in the Great Pyramid. What Miss Edwards, for instance, regards as proved beyond further question, carries with it a great deal which she appears to regard as more than improbable. I will run briefly through the considerations which seem, to my own mind, logically convincing in this respect:—

Either the Egyptian rulers were greatly interested in the advance of astronomical and astrological learning for its own sake, or they were not. If they were *not*, it would be very unlikely that merely for the sake of such astronomical purposes as the structure might subserve at certain stages of its erection, they would have gone to the enormous extra expense, labour, and care involved in the construction of the great slant gallery. If, on the other hand, they *were* greatly interested in the advance of astronomy, it would be manifest to persons as familiar as they obviously were with astronomical relations, that little of real importance could be added to their knowledge by an observing gallery only available for a few years; they would have recognised the absolute necessity, if they would effectively advance their science, of an observatory so constructed as to be available for centuries. Seeing, then, that whether the Egyptians were, or were not, greatly interested in the advance of astronomy, they would never, for *that* purpose, have given to the Great Pyramid the qualities as an observatory which *were* actually given it at the cost of enormous extra labour, care, and cost, it follows *certainly* that the astronomical and astrological relations considered by the builders were other than those merely connected with the advance of their science—were, in fact, such as made it worth their while to devote all that skill which they evidently possessed, to employ all that extra labour and to go to all that extra expense of which the building gives evidence, for astronomical and astrological relations which *would*, in their belief, be effectively advanced during the few years that the great platform and gallery could be used for observing purposes. I can see no escape, for my own part, from the conclusion that these astronomical and astrological matters related solely to the king for whom the Great Pyramid was erected. In other words, it appears to me a demonstrated fact (whatever the interpretation of the fact may be) that while the ultimate purpose of the Great Pyramid was that it should serve as a tomb for Cheops, its primary purpose (not a secondary purpose at all) was that by means of it those observations of celestial bodies, which, according to the belief of his time, were essential for his success in life and (I have no doubt) for his welfare after death, should be satisfactorily and effectively pursued. If there is any way of escape from this conclusion, I have not seen it, nor has any Egyptologist who has ever asserted that the Great Pyramid was a tomb and a tomb only, ever indicated one. Lepsius, of all among them, took, I think, the most logical position,—in regarding astronomical evidence as not worth considering at all. In so doing, he only rejected a demonstrated fact. But to accept that fact, and not to accept what it proves, is to be wanting in the logical completeness of unreasonableness which Lepsius showed in this matter.

Indeed, the tomb theory taken alone proves a good deal which those who hold it seem to overlook. In concluding that the Great Pyramid was a great tomb, we are admitting that its erection was closely and intimately associated with the religious ideas prevalent among the ancient Egyptians when it was built. From all the indications which have reached us as to the nature of those ideas, it might be shown, I believe, even though nothing whatever were known of the Great Pyramid, except that it was very large and had been erected at such-and-such cost of time and labour, that during the lifetime of its future tenant it must have had some such astronomical characteristics as is actually possessed. If sun and moon and planets were the gods of the ancient Egyptians, and the star sphere the house in whose "many mansions" those gods moved—and there are abundant indications that such was the nature of the most ancient Egyptian cult—the aspects of the heavenly bodies were bound to be considered during life and after death in the case of every Egyptian "worth counting" (I suppose the "common-folk" were not considered worth counting at all), more particularly in the case of governors, generals, official rulers, and priests, still more particularly in the case of princes and members of the royal family, but most particularly of all in the case of him who was at once King, Prime Minister, Chief General, and Highest Priest. Knowing what we know, and inferring what we may safely infer, of the religion of Old Egypt, the wonder would rather have been that astronomical and astrological relations should *not* have been considered in the Great Pyramid—being what it was, the future resting-place of the greatest of their nation—than that we should find these relations considered so thoughtfully and so skilfully, with so much care, at such great cost, and at the expense of so much labour.—R. P.]

PRINCIPLES OF DRESS REFORM.

By E. M. KING.

"MERE novelty, divorced from the 'eternal canons of loveliness,' as Ruskin calls them, can produce only oddity of various kinds, as we see in the world of fashion, where a morbid love of change is always at hand to usurp the throne of reason, and to juggle Nature out of her most comely graces and most healthy proprieties."—*Professor Blackie's article in "Contemporary Review" for June*, 1883.

"Utility, and fitness to attain a practical end, must be as in all the useful arts; but it is there as a basis on which the beautiful is erected, or as a stem out of which it grows."—*The same.*

"There are two sides to the artistic view of the question (dress). On one side is nature; on the other art. I need go no further than to remind your readers that the human frame, if in its unsullied grandeur, is, of all the Creator's works, the most artistic. Consequently, I contend that

the dress which best adapts itself to the form and requirements of that frame has the best right to be considered artistic. The mind of man has discovered for himself a dress which, I hold, fulfils both these requisites. It remains to be seen whether the mind of woman is equal to the task of devising a similar one for herself."—*Letter by Clavering Mesnard, in* KNOWLEDGE *of June* 29.

"Women now will have to be content to wait before art (in dress) in any true sense of the term can be theirs. They have so distorted and disguised nature that art for the present is impossible. We must wait and gain a correct and right appreciation of nature before we can have any true art. Before we attempt to decorate, let us have some veneration for the divine temple of our bodies which now, while ignorantly seeking to adorn, we only desecrate. And while we are waiting and learning this great lesson, a truer beauty will arise compatible with use and fitness, and women become reformed not in dress only but in mind and character."—*Pamphlet by E. M. King.*

"Men are very near towards gaining beauty and grace in their dress, they having already secured, in a very great degree, the more essential requisites of comfort and convenience. Women, on the contrary, having sought only beauty and grace in their dress, and neglected the essentials of comfort and convenience, have, in reality, failed to secure either. Men's dress is only negatively ugly, but women's dress is positively ugly. It is not only ugly in itself, but it insists upon making the body which it covers ugly—that is, deformed. But, unfortunately, our eyes are holden that we cannot perceive this ugliness, custom having long familiarised our sight to it, and because it has been disguised by always being decked out in beautiful colours, to which it has no claim. And so it is that, for men's dress to conform to right principles, very little alteration is required; while, for women's dress to be made to answer to them, such a wide measure of reform is called for that it amounts almost to a revolution."—*Lecture by the same.*

These four passages agree on the following points:—That the foundation or basis of beauty in any useful art must be utility or fitness. That the source of beauty in art lies in the study and appreciation of Nature. That dress, being one of the useful arts, must have its basis in use and fitness; and its beauty, growing out of this as out of a stem, must be derived from a correct appreciation of the human form. That the dress which answers to the requirements of the body, and best adapts itself to the form, is at once the most useful and the most beautiful dress. That men's dress, being closely adapted to the form of the body and its requirements, is the most beautiful. That women's dress, as having little regard to use or fitness, and not adapted to the form of the body, does not possess beauty. That Fashion, which in women has usurped the throne of Reason, can never give us a dress at once useful and beautiful. That if the mind of woman is ever to become equal to the task of devising for herself a dress adapted to the form of her body and its requirements, she must dethrone the usurper Fashion which has implanted in her mind a morbid desire for change and juggled her out of the most comely graces of nature and of its most healthful proprieties, and must substitute for it the guidance of Reason and right principles. That the change required in women's minds, feelings, and habits, in order to substitute the guidance of reason for that of fashion, is so great as to amount almost to a revolution.

I have here endeavoured to put together the opinions of two men writers with those of my own, to show how far these agree with mine, and also to show that if these are correct, nothing short of a revolution can effect the change we desire.

The change from the external despotism of fashion to that of self-government of reason and right principles, is a revolution.

The change from unfitness and ugliness to suitableness and beauty is a revolution. To effect this twofold revolution the inward or mental, and the outward or practical must work together hand in hand or both remain abortive. To call in the despot Fashion to introduce a change, however practically beneficial, is useless. To believe in and subscribe to right principles without power or courage to carry them into practice is also useless.

In order to form a basis of mental self-government in dress, I have drawn up the following principles or requirements of a perfect dress. They may or may not be entirely feasible; they may or may not be altogether correct; they may be insufficient, or they may be redundant; but they are an attempt to dethrone the usurper Fashion, and to raise in its stead the guidance of reason. The requirements of a perfect dress are: 1. Freedom of movement. 2. Absence of pressure over any part of the body. 3. No more weight than is necessary for warmth, and both warmth and weight equally distributed. 4. Grace and beauty combined with comfort and convenience.

But it has before been proved that dress, to be both useful and beautiful, must be adapted to the form of the body and to its requirements; therefore, in practically carrying out the foregoing principles, clothing must follow, and drapery not contradict, the natural lines of the body. In effecting any radical change we must be careful so to bring it about as not to put ourselves, or to induce others to put themselves, too much out of harmony with our or their surroundings.

This brings me to my fifth requirement, upon which I specially desired to write, which is that it must (5) not depart from the ordinary dress of the time. I found it, however, impossible satisfactorily to discuss this point until I had clearly marked out the road we have to follow.

It may be doubted whether "the mind of man" had very much to do in bringing about the change in men's dress from a highly-decorated one to an extremely and, I may say, an over-plain one. It is more likely to have been produced by men's love of comfort and a sort of can't-be-bothered feeling, rather than by any conscious mental effort.

The task which women have before them is a far harder one than that which men had to encounter, because we have to work up through the prejudices and conventional ideas of the other sex as well as our own, and to do battle with the accumulated power and influence of various trades—an influence which seems to extend every year; for now the tailors have got hold of us as well as dressmakers, drapers, and manufacturers, all ready to rack or wreck our bodies and souls so that they may but fill their own purses; while the unreasoning and illogical male multitude tacitly back them up, looking on us as, in a measure, fair game, as a sort of *corpus vile*, which it does not much matter if fashion works its deforming and degrading experiments upon, because, forsooth, "spending is good for trade."

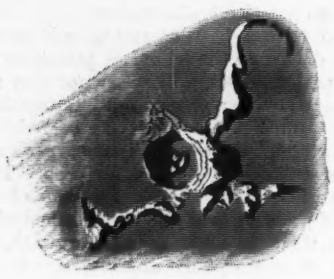
(To be continued.)

GOLD PRODUCTION IN RUSSIA.—According to a report drawn up by Mr. Irvanow, the production of gold in Russia during the year 1882 amounted to 57 million roubles (8½ millions sterling). Russia thus stands next to North America, which produces annually about 9 millions sterling, while Australia follows with 7½ millions.

THE MOON IN A THREE-INCH TELESCOPE.

BY A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

ERATOSTHENES (110), of which we spoke on p. 391 of Vol. III. as terminating the magnificent chain of the Lunar Appenines, presents a beautiful spectacle about the ninth day of the moon's age. Our drawing was made



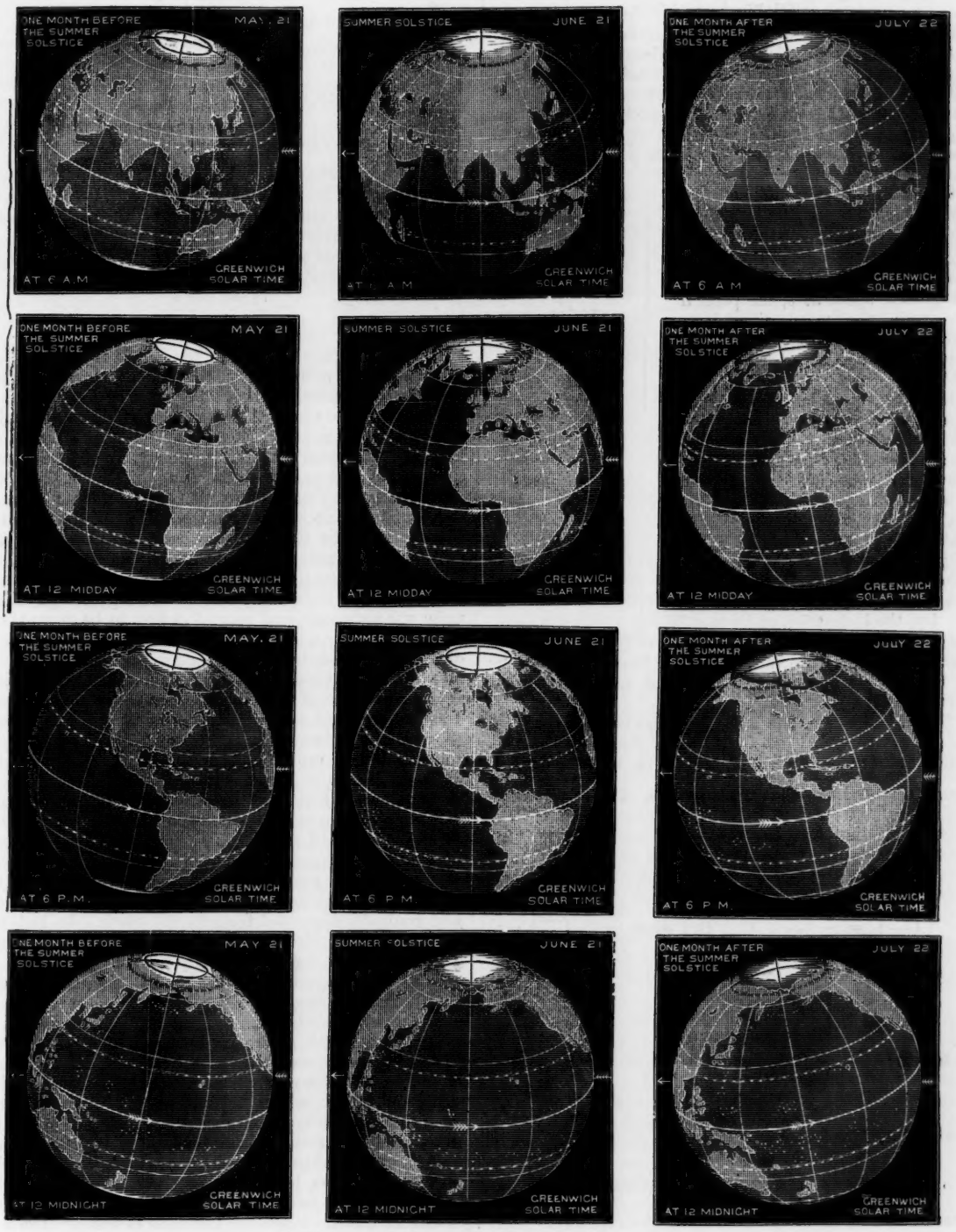
Eratosthenes. Moon's Age, 9·23 days.

with a power of 160, when the moon's age was 9·23 days. The diameter of this finely-terraced formation is about 37½ miles, and its walls will be seen to be very rugged. The three central peaks, too, are conspicuously shown under this illumination. It is curious that a formation presenting such strongly-marked features when lighted obliquely by the rising or setting sun, should be by no means easy to find at full moon. South-east of Eratosthenes will be noted a deep mountain range, terminating in a ring-plain whose walls are only some 130 ft. or so high. Hence it is only visible during a short period of favourable illumination, and forms a very severe test of the defining power of a 3-in. telescope, and of the keenness of the observer's vision. The height of the connecting ridge of mountains is some 4,470 ft. As Ben Nevis is 4,406 ft., and Snowdon only 3,571 ft. high, this may suffice to furnish a scale whereby the student may estimate the dimensions of the leading features of this neighbourhood. Schröter (106), or rather its northern vicinity, should be carefully looked at when near to the terminator, for the strange system of ramparts sloping off on either side of a central one, which Gruithuisen believed to be artificial, but which in reality consists of a series of parallel valleys. Parry (217), Bonpland (218), and Fra Mauro (219), are those more or less imperfect ring-plains which present a curious appearance when pretty near the terminator. Pitatus (186) and Hesiod (187) are a pair of huge craters, or rather ring-plains, connected by a pass. The northern wall of the former will be seen to be imperfect, while the southern wall is separated from Tycho, which we are immediately to examine, by a rugged mass of mountain peaks. The two most notable peculiarities in Hesiod are a central crater in the floor, and a cleft (shown in our map) running into the Sea of Clouds. And now we arrive at what has been aptly called by Mr. Webb, "the metropolitan crater of the moon," Tycho (180), reference to the system of streaks emanating from which has been once or twice previously made. This splendid formation, visible as a white spot to the naked eye at full moon, measures fifty-four and a quarter miles across, and exhibits an elaborately terraced wall, some 16,000 ft high on the east side and upwards of 17,000 ft. in height in its western portion. In the subjoined sketch we have purposely abstained from any attempt to

Tycho. Moon's Age, 9·24 days.

delineate the extremely disturbed and rugged region surrounding Tycho, confining ourselves strictly to drawing the crater itself. The central hill shown above is between 5,000 and 6,000 feet high, its conical shadow being very conspicuous at the time our drawing was made. The inextricable mass of craters, hillocks, pits, and irregularities in the immediate neighbourhood of Tycho almost defies any attempt to draw or map it. The wonderful system of light rays radiating from this great crater extends over at least a quarter of the entire visible hemisphere of the moon. Some of them may be traced to the southern limb, and doubtless extend beyond it into that hemisphere which is always hidden from the terrestrial observer. One tremendous ray passes through the Sea of Serenity, the craters 70 and 73 in our Map (Vol. III., p. 223), lying upon it. Another very conspicuous one connects Tycho with the interesting formation Bullialdus (213). It is a notable fact that while these rays in nearly every other instance pursue their course through hill, valley, crater, and plain without deviation or interruption, the crater Saussure (196) has deflected one of them, and caused it apparently to bend round its southern wall. *What* these stupendous bands are can only be regarded, at present, as a mystery. Nasmyth considers them to be cracks filled up with molten lava from the Moon's interior; but arguing from their terrestrial analogues, trap-dykes, we should expect to find them projecting more or less above parts of the lunar surface, and, as a necessary consequence, casting shadows when on or near the terminator. As a matter of fact, we find them, everywhere, absolutely level with the regions which they traverse. Of whatever material they are composed, its reflective power must be very high, inasmuch as the ray-system of Tycho traverses the (in many cases) huge and complicated formations, Sasserides (183), Gauricus (185), Heinsius (190), Wilhelm I. (191), Longomontanus (192), Clavius (193), Maginus (195), Orontius (197), Nasir-ed-din (198), Lexell (199), Walter (200), Moretus (262), Stöfler (354), and Maurolycus (358), all which are most conspicuous objects when obliquely lighted; but which, one and all, disappear wholly at full moon, or under vertical illumination! The late Professor Nichol, amid much which, after all, merely amounted to assertion, did point out one valuable piece of evidence furnished by these rays; and that is, the proof afforded by their continuous visibility and the homogeneous character of their brightness throughout their course, that the reflective substance of which they are composed is absolutely everywhere uncovered. Did anything in the shape of vegetation, for example, exist in the moon, it must obscure portions of these light streaks. That they pass undimmed, then, from their origin to their termination, shows plainly enough that they traverse "a rocky desert, devoid of life or living thing." Here our night's work may cease. We shall turn our telescope upon Copernicus (112) as soon as it is favourably illuminated

One Month before Summer Solstice. | Summer Solstice. | One Month after Summer Solstice.



SUN VIEWS OF THE EARTH;

OR, "THE SEASONS ILLUSTRATED."

By Richard A. Proctor.

I GIVE this week our Sun Views of the Earth for the month, showing the aspect of the earth as supposed to be seen from the sun at six in the morning, noon, six in the evening, and midnight of Greenwich solar time, one month after the summer solstice. For comparison, I repeat the Sun Views for June and May.

XUM

FLIGHT OF A MISSILE.

By RICHARD A. PROCTOR.

PROP.—*To determine what westerly deviation is produced in the case of a missile fired vertically from the equator to a height* h (*the resistance of the atmosphere being neglected*).

The real cause of the westerly deviation is the action of gravity during the time of flight retarding the motion originally possessed by the missile at right angles to the line joining the earth's centre and the point whence the missile was projected.

Let $a\,b\,c$ be part of the equator, a the point whence the missile is projected vertically, with velocity $\sqrt{2\,gh}$, so that it reaches the height h in time t_1, and in time $2\,t_1$ reaches the ground again at b, the point a having in the mean time been carried to c, so that $b\,c$ is the westerly deviation we require to determine.

Let c' be the point in a T which a body moving in the straight line a T with constant velocity v would reach in time $2\,t_1$, b' the point which it would have reached if constrained to move in the straight line a T, but with its velocity in this direction, v at starting, affected by the action of gravity, so that $b'\,c'$ is the deviation we require; for the arc $a\,c$ is so small that for the purpose of this inquiry, the inclination of $b\,c$ to a T may be neglected. We also may manifestly neglect the variation in the force of gravity due to the varying distance of the actual missile from the earth's surface.

Suppose that in time t the body has reached the point X, put $a\,\mathrm{X} = x$, and join C x (C being the earth's centre). Then the retarding action of gravity on the body at X is equal to $g\frac{x}{r}$ (r being the earth's radius). Hence we have—

$$\frac{d^2x}{dt^2} = -\frac{gx}{r}$$

$$\frac{2d^2x}{dt^2}\cdot\frac{dx}{dt} = -\frac{2gx}{r}$$

and $\left(\frac{dx}{dt}\right)^2 = -\frac{gx^2}{r} + \mathrm{C}$. But when $x=0$, $\left(\frac{dx}{dt}\right) = v^2$

$$\therefore \left(\frac{dx}{dt}\right)^2 = -\frac{gx^2}{r} + v^2$$

$$\left(\frac{dt}{dx}\right)^2 = \frac{r}{rv^2 - gx^2}$$

and $$\frac{dt}{dx} = \sqrt{\frac{r}{g}}\,\frac{1}{\sqrt{\frac{rv^2}{g} - x^2}}$$

wherefore $$t = \sqrt{\frac{r}{g}}\,\sin^{-1}\left(\frac{x}{v}\sqrt{\frac{g}{r}}\right)$$

or $$x = v\sqrt{\frac{r}{g}}\,\sin\sqrt{\frac{g}{r}}\,t \quad (\text{Constant} = 0)$$

Hence, since in time $2t_1$, the body is at b', we have

$$ab' = v\sqrt{\frac{r}{g}}\,\sin\sqrt{\frac{g}{r}}\,2t_1$$

$$= v\sqrt{\frac{r}{g}}\left[\sqrt{\frac{g}{r}}\cdot 2t_1 - \sqrt{\left(\frac{g}{r}\right)^3}\cdot\frac{8t_1^3}{2\,.\,3}\right]$$

[approximately

$$= 2vt_1 - \frac{8v}{2\,.\,3}\cdot\frac{g}{r}\,t_1^3$$

But $ac' = 2vt_1$

$$\therefore b'c' = \frac{4}{3}\,\frac{vgt_1^3}{r}$$

Now $n = \frac{gt^2}{2}$; and $v = \frac{2\pi r}{\mathrm{P}}$

$$\therefore b'c' = \frac{8h}{3}\cdot\frac{2\pi t_1}{\mathrm{P}} = \frac{16\pi h t_1}{3\mathrm{P}}$$

the same result which was obtained by the simpler method of regarding the missile after it had once left the earth as travelling in an elliptical orbit around the earth's centre, and subject, therefore, to the second law of Kepler.

If the missile is projected in latitude λ, it may easily be shown that the westerly deviation

$$= \frac{16\pi h t_1 \cos\lambda}{3\mathrm{P}}$$

THE mean daily motion of the air in 1882 was 306 miles, being 27 miles greater than the average. For the month of November, the mean daily motion was 449 miles, being 150 miles above the average. The greatest daily motion was 758 miles on Nov. 4, and the least 30 miles on Dec. 11. The greatest hourly velocity was 64 miles, and the greatest pressure—with the chain—29 lb., on Oct. 24.

REMARKABLE PHENOMENON IN GLENISLA, FORFARSHIRE.—About two o'clock on the afternoon of Wednesday, the 11th current, the sky was very dark, and I was on the outlook for thunder, when, standing at Broomhall, in Glenisla, my attention was attracted by a peculiar noise, similar to that produced by a train crossing a bridge. This noise was very loud, and seemed at first to be distant, but latterly it came quite near, and sounded like the rapid discharge of musketry, with a booming sound. There was no rain at this time, but a few minutes before there had been a heavy fall of rain, accompanied with a thunder-peal. I looked up, and saw about a mile away a large cloud twisted in the form of a screw, and revolving round and round at a very rapid rate. It looked like a huge column of steam, and cloud, and vapour, about fifteen yards in breadth, and so high that the top of it went out of sight. It was narrow towards the earth, and spread out in its screw form as it reached its extreme height, with huge volumes of what looked like steam or smoke in its train. The effect was grand. It rose above the horizon, which from my point of view was formed by a wooded hill on the south, and gradually descended towards the earth. It had two motions, one circular and the other forward, and the latter I guessed to be at the rate of a mile in 2½ minutes. It seemed to be engulfing everything in its vortex, and was scattering branches, and what appeared to me pieces of burnt paper, but which turned out to be slates. The air was pervaded with a strong sulphurous smell. I followed the vision, which was that of a "rushing mighty wind," over the other line of the horizon to the north towards a mill-pond, from which it sucked up water in great quantities, which appeared to be absorbed and scattered in its weird-like dance. On further inquiry I found that this same visitant had in this immediate neighbourhood knocked down stone dykes, levelled trees, tirred a cottage, which it shook, shattered its chimney-cans in a thousand pieces, and scattered the zinc ridges for hundreds of yards. The fields in its train are strewed with limbs of trees, slates, and splintered wood, and the whole advent was so solemn as to strike with terror men, women, children, and the beasts which were in the field; and doubtless others of your correspondents will recount its story and tell its name.—*Dundee Advertiser.*

Editorial Gossip.

MY lecture audiences in the Philharmonic Hall, Southampton, very considerably exceeded the "small dozen" which an astronomical resident assigned as the total number here who take the least interest in astronomy. In fact, they were excellent audiences, both in size and quality. It was particularly pleasing to me to find that the numbers present increased as the course proceeded. I regretted the more that the third lecture was given under considerable difficulties, and, indeed, ought not to have been given at all. I was a passenger by the 7.50 train from Portsmouth on Saturday morning, which ran into a heavily-laden excursion train, and have felt since (like Pete Jones after his encounter with Bud Means) "consid'able shuk up." It was a somewhat singular experience to me to lecture under such conditions, and I was interested to find that for the greater part of the time the mere mechanical action of speaking went on, or seemed to go on, almost without thought. But the effort was trying, and I shall be careful how I repeat it before I have recovered my customary working powers.

GOOD service may be done occasionally by showing the class of readers who place reliance on anonymous criticisms, the shallowness of average criticism, and the dishonesty of a good deal which is below the average in one sense, but in cleverness often rather above it. A criticism of my Mysteries of Time and Space, by no means unkindly in tone, though amusingly corrective considering the writer's manifest inexperience, has been sent me by a good-natured friend (never mind the theological participle), for notice, I suppose. It appears in the usually rather caustic pages of the *Saturday Review*, but I must admit that the purpose of the writer seems throughout to impart information, not to cauterise the poor author. This is kindly meant, and as I should imagine from his remarks that my friendly critic really has given an hour or two for every year that I have given to the subjects about which he wishes to set me right, he stands manifestly on higher ground than the average critic. That he has not read my book is clear enough, from his remark that the essay on "Herbert Spencer's Philosophy"—which introduces most stupendous "mysteries of time and space"—has no business in the book at all, and from his reference to Mr. Spencer's special law of the "Persistence of Force," which might be erroneous, yet his philosophy sound. But it is an exceptionally honest critic who reads everything on which he comments, and my critic really is very fairly honest. Nine-tenths of his corrections present only misapprehensions of his own.

WHAT I wish specially to note in this criticism is the following remark on my essay, "A Survey of the Northern Heavens":—"Mr. Proctor, who has investigated the matter very carefully, maintains that at the end of his life Herschel gave up all belief in either of his two methods of 'star-gauging;' but we could wish that he had noticed the arguments on the opposite side which have been lately put forward by Professor Holden in his short 'Life and Works of Sir William Herschel.'"

I BELIEVE that I have given to the study of Sir W. Herschel's papers more time and attention than anyone else has yet bestowed on them, not excepting William Struve, who however is a long way ahead of all others in this respect. His conclusions and inferences are almost exactly the same as mine, neither of us, by the way, having ever suggested any such absurdity as that which the critic attributes to me. Herschel never "gave up all belief in either of his two methods of star-gauging," but he did give up the theories he had based on them. But if I had not been content with my own and W. Struve's study of Herschel's papers, it is at least not likely that I should notice arguments respecting them put forward by Professor Edward Holden, formerly of Washington and now of Ann Arbor, Mich., celebrated for years past as the man who has most notably surpassed the usual achievements of book-reviewers. They have sat in judgment sometimes on books they have not read, and it is whispered that one or two of them have sat in judgment on books they have not even seen. But Prof. Holden, aiming only at the latter achievement, unfortunately shot so far beyond his mark as (unwittingly) to pronounce judgment on a book which—though announced for early publication two years before—had not been completed, and has not been published yet! *His* remarks on the long and difficult series of papers written by Sir W. Herschel must be worth noticing indeed!

THERE is a good illustration in a recent number of *Nature* of the risk arising from the constant custom of putting a comma before "which." In an article on cholera, a writer is made to say "that the disease has, in this country, been mainly associated with the use of water supplies, which have been subjected to the risk of receiving special infection." I daresay the compositor supposed that in throwing in the comma he was correcting slipshod punctuation. As a matter of fact he made the author he was correcting teach that we should refrain from the use of water supplies (which would be awkward), and for the reason (which would be rather scaring, if true) that our water-supplies have one and all been subjected to the risk of receiving special infection.

I AM glad to see that our musical critics, who usually waste a good deal of their ink in writing fanciful nonsense, have begun to notice the evil habit which some of our operatic singers have of showing off their voices at the expense of their parts. Albani is a great offender in this respect. With a magnificent voice (the musical critics will smile at such a word as "voice" being used, instead of the impressive "organ"), Albani sometimes gives pain to hearers who really love music by introducing into some expressive phrasing a marvellous bit of trilling, as utterly out of place as a somersault would be towards the close of Hamlet's suicide soliloquy. If Nilsson or Patti, who, we know, *can* achieve all that Albani does, were to lose no opportunity of doing so, they would not hold the place they do in the hearts of all who prefer singing to musical gymnastics.

BY-THE-WAY, might not something be done to teach audiences how and when to applaud. Perhaps some of our singers, especially at concerts, are more to be blamed than the audience, for often by their action they suggest that the right time to applaud is when their own voices cease to be heard. Be this as it may, much sweet music is lost through the stupid habit of those listeners who think only of the voice, and drown what Beethoven, Mozart, or Rossini (who perhaps knew rather better than these noisy ones) thought an essential part of the performance. One often feels that concerts and operas could only be properly enjoyed if none were admitted to hear them who did not know something and care something about music. As it is, more than half our audiences seem to be of the opinion of Lord Foppington, that listening to the music, though "pardonable in the country," is "a monstrous inattention in a polite assembly." But this is a very old trouble.

XUM

CHOLERA.

(*Preventive.*)

To the Editor of KNOWLEDGE.

THE progress which medical art combined with sanitary arrangements have made since 1866, has greatly diminished the dread of this epidemic. Yet forewarned, forearmed; for not to be watchful against danger is foolhardy. The most important thing is not to be afraid of it, since terror, fussing, and worry destroy more than disease. Pay very strict attention to body and home cleanliness, diet, and daily exercise, with avoidance of heavy drinks, greasy substances, and fruits.

In my large London parish the following proved most successful:—Experience has taught me that more depends upon pure water, boiled (best) or filtered, than anything else. A simple filter (costing a few pence) is made out of a common 6-in. garden pot plugged with sponge; at the bottom a layer of 1½ in. of powdered wood or bone-charcoal, then 2 in. of silver sand, and on top 1½ in. clean washed small pebbles. Renovate every eight or ten weeks. Or Atkins' (62, Fleet-street, London) splendid carbon filters, 2s. 6d. to £2. 2s.; or Lipscombe's, 233, Strand. If diarrhœa or pains come on, the following reliable Indian remedy, which has been very successful during previous visitations in London, and which your chemist can make for 6d. to 7d.—and taken within a quarter of an hour—will prove very beneficial:—

Sp. pro Mist. Cretæ	℥ss.
Conf. Aromat.	℥iss.
Tinct. Catechu.	℥iss.
Tinct. Opii	m.xx.
Ol. Cinnam.	m.vj.
Aquæ	Ad. ℥vj.

Fiat Mist.

Adults ..... 3 table-spoonfuls every 3 or 4 hours.
Ages 7 to 16 ... 1½ „ „ „
„ 4 to 7 ..... 3 teaspoonfuls „ „
„ 3 to 4 ..... 2 „ „ „
„ 1 to 2 ..... 1 „ „ „
„ Under 1 ... ½ „ „ „

(Beef tea, mutton broth, arrowroot, boiled rice.)

Always keep some of the mixture in store, also a bottle of Dr. Collis Browne's Chlorodyne. If any complications arise, without a moment's delay call in your doctor. I hope what formerly proved so efficacious may be again beneficial to my fellow-creatures.—A. STYLEMAN HERRING, Vicar of St. Paul's, Clerkenwell, London.

THE EDISON ELECTRIC LIGHT.—The Criterion Theatre, Piccadilly, is to be lighted throughout with about six hundred Edison incandescent lamps. The generating plant will comprise two Armington & Sim's horizontal high-speed engines, having 13″ cylinder by 13″ stroke, running at 275 revolutions per minute, and driving on to counter-shafting, from which will be run four Edison *L* dynamos, each capable of sustaining 150 16-candle lamps. Each engine will be capable of indicating 84 h.p., at 70 lbs. pressure, and either engine will thus be able to take the whole load in the event of accident or repairs to the other. The wiring will be arranged on eight circuits, each under independent control by means of a specially designed regulator, capable of lowering or raising the brilliancy of the lamps from normal candle power to *nil*. The contract for the work, which will be carried out by the Edison Electric Light Company, stipulates for the completion of the installation by the beginning of September.

"Let Knowledge grow from more to more."—ALFRED TENNYSON.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the EDITOR OF KNOWLEDGE; *all Business communications to the* PUBLISHERS, *at the Office, 74, Great Queen-street, W.C.* IF THIS IS NOT ATTENDED TO, DELAYS ARISE FOR WHICH THE EDITOR IS NOT RESPONSIBLE.

All Remittances, Cheques, and Post Office Orders should be made payable to MESSRS. WYMAN & SONS.

The Editor is not responsible for the opinions of correspondents.

NO COMMUNICATIONS ARE ANSWERED BY POST, EVEN THOUGH STAMPED AND DIRECTED ENVELOPE BE ENCLOSED.

LARGE SUN-SPOT.

[880]—It may interest "Excelsior" (letter 866, p. 29) to learn that I measured the fine spot—or rather group of spots—to which he refers, on June 30, and that the total superficial area of the sun involved in that stupendous disturbance amounted to 1,837,310,200 square miles! The superficial area of our own world, it may not be unworthy to note, is only 197,000,000 square miles.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

GEOMETRICAL AND REAL PERSPECTIVE.

[881]—It is the practice of artists to exaggerate the size of distant objects. Imagine, for example, in a landscape, a distant hill with a lake in front of it, and a man walking across the foreground so that the observer sees the collar of his coat in a line with the top of the hill, and the end of his coat-tails with its base; the artist will probably show the top of the hill above the man's hat, and the base correspondingly low. When the sketch is compared with a photograph, it looks correct, but the photograph makes the hill look too small. The following is suggested as a likely explanation:—

The camera takes its picture in true geometrical perspective, except as regards slight errors due to the lenses, and differences of focus. By using a camera with a small hole, instead of lenses, these may be avoided. In the camera the man's coat takes the same height on the screen as the hill does, but still, in the photograph, the hill looks too small. On looking at a picture or photograph, the eye has not to alter its focus, and can see two objects supposed to be at different distances simultaneously, and sharply defined. Thus, on looking at the photograph, the coat covers the same height on the retina as the hill does; but in the case of the picture the hill corresponds, perhaps, to the man's coat, hat, and other kind of garment, which, by-the-bye, the artist will have shown bright red for the sake of the blue and yellow of the picture. In looking at the real scene, the eye has to adapt itself to the different distances, as it cannot look at near and remote objects at the same time. On looking from the man's coat to the hill, it alters its focus; and this it does, not like a lens camera, but by increasing the focal length of its lenses by flattening the crystalline lens. A result of this is, that the image of the hill on the retina is enlarged, and occupies more height than the man's coat did when in focus, justifying the artist's practice.

The effect of this action of the eye is easily seen by holding a pencil, or anything suitable, between the eye and a distant object, and looking from it to the pencil and back quickly. The object appears to change its size. By holding the pencil so as to subtend the same angle as some dimension of a distant object of striking colour, and then, having previously looked at the object till the eye is somewhat fatigued, looking at the pencil, the images on the retina may be compared, as the object will still be visible in complimental colours.

JAS. SWINBURNE.

SINGULAR PHENOMENON.

[882]—A short time ago, I was pricking out some annuals on a flower-bed, on which some geraniums were already planted, when I was surprised to see flashes of light coming from a truss of geranium flowers. At first I thought it was imagination, but my wife

and a friend who were present also saw them. Time was about 9 p.m., and the atmosphere clear. There were other geraniums of a different colour on the same bed, but there was no effect on them. The particular geranium was a Tom Thumb.

Is this at all common? I have never seen or read of it before.

S. INGHAM.

SKYERS.

[883]—With reference to your note upon the absurd statement of the "Spectator" that a "skyer" can only result from a drive, will you allow me to point out that nothing is more common than for a batsman to hit *under* the ball in hitting to leg, with the almost invariable result of sending it spinning over his shoulder towards "long slip," or, perhaps, "third man;" and such a hit is a veritable "skyer," both in a literal and what one may call a technical sense.

A "skyer" from a *late* hit to leg would be indeed a curiosity. I should be sorry to be keeping wicket when it happened.

F. M. D. UPLOCK.

[Yes; I knew a bowler who had a favourite dodge based on the fact mentioned by Mr. Uplock. When bowling to a batsman who favoured leg-hitting, he would send an occasional leg-ball with a break from the off-side, or *away* from the wicket. Such a ball, pitched rather forward, is very apt to be hit under, with the result of sending a "skyer" to long slip. Especially is this the case if it comes after several leg-balls sent down with the right sort of break for taking the wicket—that is, a break from leg.—R. P.]

DRESS REFORM—MEN.

[884]—I am in my "forties," and since my youth have discarded braces, belt, or buckle. I merely have my trousers made to a "nicety," to fit just over the hip. Anything more comfortable is beyond my imagination. I think my tailor has not taken my measure more than two or three times during my "career," so that this ordeal has been avoided.

A. G.

[Unfortunately some men, oppressed with over-much adipose tissue, have no hips worth mentioning.—R. P.]

RATIONAL DRESS: THE KILT.

[885]—In all the letters and papers which appeared in KNOWLEDGE on dress, I am surprised that our national dress, the *kilt*, has not been referred to. Those of us who are in the habit of, at times, wearing it, and at other times trousers, know how much more comfortable and pleasant it is than the latter. Two things, however, are indispensable to this comfortableness and pleasantness. (1) That it be made so as to balance perfectly and hang all round with an equal weight, and (2) that it be fixed with large pins, and with no such things as straps and buckles attached to it. The difficulty is to find a tailor who knows how to make a kilt which will balance. For ten years of my life, having worn nothing else, I can speak with full knowledge. Perhaps my friend Dr. Gillins, who has been associated with me in other Celtic matters, can throw some light on its healthfulness.

CHARLES STEWART.

EARTH-SHINE.

[886]—While looking at the moon recently with a $3\frac{3}{4}$ equatorial, the "Earth-shine" was most distinctly visible. A friend, to whom I pointed it out, saw it also most plainly. I was not aware before that this was visible when the moon is *eight days old*.

W. H. K. SOAMES.

[It is very seldom so seen in England. In America and Australasia I have seen it—even later.]

FIGURE-CONJURING.

[887]—It may surprise "G. M." to know that the figure-conjuring he read of in a French book was practised upon verdant students of mental arithmetic in my early days at an ordinary English elementary school, only the ending was varied. Instead of asking the youthful arithmetician to hand him a slip of paper showing the final product, the "conjuror" would say: "Now, deduct the number you first thought of," and afterwards proclaim the result, *without seeing any paper, or being told anything.* Between boys who were in the secret the whole method was worked mentally, by way of exercise, but four figures were "one too many" for us.

A. B. C.

A VERY COMPLETE MAGIC SQUARE.

[888]—In looking over the early numbers of KNOWLEDGE, my attention was drawn to an arranged square of nine, on page 273, Vol. I., copied from a tablet inserted in the wall of a villa near Rome when it struck me that I could improve upon that arrangement, and accordingly I have succeeded in constructing a square of nine, beyond which I think it would be difficult to go. In the accompanying figure the number 369 is produced by each vertical, horizontal, and diagonal row of cells; by the angles, whether right, acute, or obtuse; from the corners, or the middle from the centre, which will still hold true should both side rows, or top and bottom rows, or all four be taken away. The next rows, in a similar manner, may be removed with like results. The figure is divided into nine smaller squares, each of which contains the number 369. Should we take the diagonals of any three of the smaller squares lying in a line of which the central square is one, the same number is obtained. In fact, any three cells with their corresponding opposites with any three of the central squares which form a line passing through cell 41, or any four taken in a like manner along with that cell alone, will produce the same result, nine cells always being necessary for the purpose, of which the central must in most cases be one. A very little investigation will show the principle upon which the figures has been constructed. In how many ways can the number 369 be produced?

G. S.

35	16	28	10	63	76	70	50	21
56	45	79	30	5	38	31	71	14
36	65	9	58	67	22	49	1	62
64	42	8	75	29	23	2	48	78
25	43	69	27	41	55	13	39	57
4	34	80	59	53	7	74	40	18
20	81	33	60	15	24	73	17	46
68	11	51	44	77	52	3	37	26
61	32	12	6	19	72	54	66	47

MECHANICAL PUZZLE.

[889]—Here is a mechanical question which puzzles, and which I should like inserted in KNOWLEDGE, with a view to its solution:—If a body moves with a certain velocity, it has a certain amount of kinetic energy; if at twice that velocity, its energy is four times the first amount, for the energy in a moving body is as the square of its velocity. Now, when a person moves a body (say throws a stone) the work he does or energy he expends is in proportion to the V^2 of the body moved (assuming the mass to be constant). Suppose A to throw a body with a velocity V, and suppose B to be riding alongside of that body and at the same rate (V) to B, the body will be relatively at rest. Let B now lay hold of the body and give it a new velocity V, the body will now move with a velocity 2 V, and have, therefore, *four* times the energy that it had at first; but A and B have done equal work on the stone, each imparting a velocity V, and therefore an energy equal to one-fourth of what the stone now has—together equal to one-half? Where does the other half of the energy come from?

FORCE.

[From the horse, or other animal on which our friend B may be riding.—R. P.]

PROBLEM IN PROBABILITIES.

[890]—I send you a question in probabilities which appears to me to be rather peculiar, and shall be glad of your opinion on it, or that of your correspondents.

Required the separate chances (1) of dividing; (2) of taking the whole of a six pool. N.B.—Players of equal skill.

Since one out of the six players must either take the whole or divide, and each has the same chance of doing so,—

chance of either dividing or taking the whole for each player $= \frac{1}{6}$

Again, each player may divide in five ways, but can only take the whole pool in one way. [But are the six chances here considered equal?—R. P.]

Assuming, therefore, that the chance of dividing : the chance of taking the whole :: 5 : 1 we get—

Chance of dividing ..... $= \frac{5}{36}$

„ „ taking the whole $= \frac{1}{36}$

But is this reasoning correct?

HAZARD.

LETTERS RECEIVED, AND SHORT ANSWERS.

JOS. CLAYTON. Yes; the planetary aspects were evil, in the astrological sense, when those particular catastrophes happened. But it would be hard for all the catastrophes to happen when the planets were more smilingly arranged. If you know anything of astrology, you know that about one-third of the time the aspects are evil; for another third they are good; for the rest of the time they are both good and evil. Consequently, for two-thirds of the time you can indicate evil planetary aspects. Thus, in the long run, two-thirds of all the catastrophes will occur when the planets, according to astrologers, threaten evil. Leave the other catastrophes out of consideration, and—there you are: astrology is shown to be a true science. Only as a mere detail, so to speak, it may be noticed that if the good aspects were regarded as the evil and *vice versâ*, astrology would be just as satisfactorily established.—SENEX. (1) Unfortunately, pictures of spots could only appear after the spots had gone out of view. Then what use would they be? They would be meant, I suppose, for telescopists, and the telescopist can see them for himself. (2) It often happens that the penumbra of a spot looks widest towards the nearer edge of the sun. The circumstance is considered and illustrated in my book on the sun. It does not militate against the theory of spots being cavities, but shows that the evidence which has proved them to be cavities is not always presented.—J. B. *Ask* your plain question; you omit this trifling detail in your last letter. Dictionary meanings of such words as "level," "horizontal," &c., are, nine times out of ten, wrong.—W. LALANDE. Nothing personally.—S. INGHAM, F. Ω L. See Mr. Theobald's advertisements.—AN INQUIRER wishes to learn the name and author of any exhaustive work on the history, manners, character, &c., of the Chinese. — TRESILLIAN, MORE LIGHT. It would afford a very inconvenient precedent to do what you wish, or I would, gladly. — AN INTERESTED READER OF "KNOWLEDGE" would like to see a protest here against the wholesale destruction of butterflies for stocking collections; also to learn if the leaves of the garden rhubarb are poisonous, and if water in which potatoes have been boiled is unwholesome. An "I. R. of K." mentions also an amusing instance of ignorance in a charwoman, who, having accidentally run the nib of a rusty pen into her thumb, covered the *nib* with grease and put it carefully away on a shelf, to prevent her *thumb* from festering.—A LOVER OF THE STARS. If you were on a world travelling round Alpha Centauri, and could see both the Sun and Neptune, you would find the distance between them equal to about 32 seconds of arc, or, in other words, they would appear as a rather wide double star, not like Gamma Virginis.—JAS. SWINBURNE. Thanks.—HUGH DALZIEL. Rather more suitable to *The Field* than to these columns.—Rev. W. HARDMAN, LL.D. Considering the nature of the subject, may we not admit on both sides that *some* problems in psychology, which in former times were explained as due to spiritual agencies external to our personality, may be rationally explained *now* as due to processes simply natural? If the "some" of several be "all," while the "some" of other some are few, the contest over *that* difference should be waged elsewhere. Mr. Clodd, you may be sure, meant no scorn for accepted beliefs about external agencies; nor does he definitely reject them for all cases. But you must admit that many cases of supposed demoniac influence have had an internal, not an external origin.—LEONARD RODWAY. The indestructibility of energy is really against your views. If the earth is constantly radiating heat into space, she cannot retain it unchanged in amount within her own globe. So long as the crust is drawing on the internal supplies, it is natural that there should be little *apparent* change of temperature.—W. G. MORTIMER. Do not know the address of the Ladies' Dress Reform Association.—J. HOMER. Such an article might be of interest. Must see it before I can say.—C. G. MEETKERKE. Thanks, but paper not suitable; shall it be returned?—J. LAWSON. In early numbers of KNOWLEDGE a great number of magic squares were given. See Mr. Sutton's square of 9, shortly.—J. M. GLADSTONE.—The figure simply gives the lengths corresponding to vibrations for various notes.—M. GRIFFITHS. The question is scarcely an optical one. People do not really estimate the size of the sun when they say it looks as large as a cheese-plate, a sixpence, a round table, or so forth. Its apparent size is the same for all, and not a matter for estimation, except for those who wish to learn precisely how many seconds of arc the disc's diameter really subtends. When anyone says the sun looks as large as, say, a halfpenny, he really asserts that it seems to him about nine feet away, for at that distance a one inch globe (a halfpenny is exactly one inch in diameter) would look as large as the sun.—W. T. SOUTHWARD. I can only say that I differ from you. If science said dogmatically there is no such thing as a disembodied spirit, there is no future life, and so forth, your objections would be sound enough. But that science should not be permitted to discuss the ascertained origin of many of the beliefs men have formed and formulated respecting matters spiritual, seems to me altogether absurd. If you are right, I am not a recent offender, or officially so only (as editor, to wit) against your doctrine. In the Essay on Ghosts and Goblins, in my "Borderland of Science," I consider certain cases of supposed apparitions, and show how they were to be explained. This, of course, is not the same as asserting that ghosts and goblins never can appear or have appeared; yet you would say that I had no business even go so far, and that you consider science is "degraded by attempts to explain," &c. It is absolutely certain that many races have based doctrines about disembodied spirits, a future life, heaven, hell, &c., on mistaken notions about shadows, dreams, optical phenomena, the sky, subterranean fires, and so forth. To show this is not to assert that there is no future life, no disembodied spirit, no spiritual Heaven or spiritual Hades; and undoubtedly science has the fullest possible right to consider the origin, progress, and decay of mistaken interpretations of shadows, dreams, the arched sky with its celestial phenomena, sulphurous volcanic regions, *und so weiter*. Whether ideas about disembodied spirits, heaven, hell, &c., are in themselves right or wrong, makes no difference in this respect. If they are wrong, there is nothing to be said for them; if they are right, they cannot be too soon dissociated from erroneous explanations.

Our Mathematical Column.

GEOMETRICAL PROBLEMS.

BY RICHARD A. PROCTOR.

PART IX.

WE may remark in passing that there is no absolute necessity for restricting ourselves in all respects to Euclid's manner. Take as an instance his treatment of the famous *pons asinorum*. In dealing with this, as with all other propositions, he confines himself entirely to constructions which he has shown to be possible. Therefore, the following proof of the first part of the proposition would not be *in his manner*, though it would be difficult to find any flaw in the reasoning.

There must be *some* line which divides B A C (Fig. 17) into two equal angles.* Let A E represent this line. Then in the triangles B A E, C A E, B A is equal to A C (*hyp.*); A E is common; and the angle B A E is equal to the angle C A E. Therefore (by I., 4) the angle A B E is equal to the angle A C E.

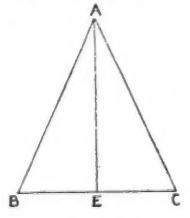


Fig. 17.

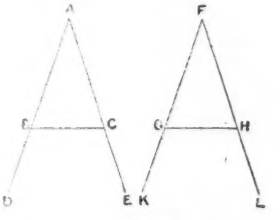


Fig. 18.

Again, the following proof of both parts of the proposition is complete, though not in Euclid's manner:—

Conceive that the figure formed by the lines F K, F L, and G H, Fig. 18, is one that would coincide exactly with the figure formed by the lines A D, A E, and B C; F K coinciding with A D (Fig. 18), F L with A E, and G H with B C. Now conceive the figure F K L to be turned face downwards, and so applied to the figure A D E that F K may coincide with A E; then since the angle G F H is equal to the angle C A B, F L coincides with A D. Also since A B, A C are equal to each other, and also to F G, F H, the points G and H coincide with the points C and B, and G H with C B. Thus the angle A B C coincides with and is equal to the angle F H G. But by our supposition the angle A C B is equal to the angle F H G. Therefore the angle A B C is equal to the angle A C B. In like manner D B C coincides with G H L;† but, by our supposition, B C E is equal to G H L. Therefore D B C is equal to B C E.

* The assumption here is precisely the same in character as that made in defining a right angle.

† Here we assume as axiomatic the property which Simpson has attempted to prove in the corollary he has added to I., 12. He forgot, apparently, that Euclid had already (in prop. 4 and elsewhere) assumed the property as self-evident, and that prop. 12 itself cannot be solved on any other assumption.

Or, we may produce A B and A C in Fig. 17, and conceive the part of the figure to the right of A E rotated round A E till it falls on the part to the left, and then show the perfect coincidence of the two portions.

In attacking geometrical deductions we are often compelled to assume in this way the existence of figures which are clearly *conceivable*, though we may not know precisely how to construct them, or though it may even be impossible to construct them by any of the ordinary geometrical processes. The following example of a problem in geometrical maxima and minima affords an instance.

Ex. 11.—*A C B, Fig.* 19, *is part of a circle whose centre is at O. The points P and Q lie without the circle. Determine under what conditions the sum of the distances P C and Q C will be a minimum.*

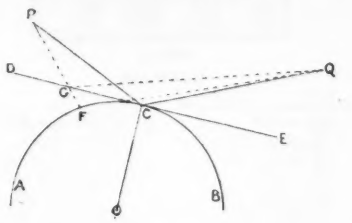


Fig. 19.

Here guided by Examples 8, 9, to which the above is supposed to be given as a rider, we are readily led to the inference that P C and Q C should be equally inclined to the tangent at C. Now there is no simple method of determining C so that this relation may hold. But it is clear that there must be *some* position of C for which it holds. Conceive, then, that P C and Q C are equally inclined to D C E, and let us inquire whether their sum is a minimum. Take any point F in A C, and join P F and Q F. Then we have to show that P F and Q F are together greater than P C, C Q. Let P F meet D C in G and join G Q. Then P G and G Q are together greater than P C and C Q (Example 9); and P F, F Q are clearly greater than P G, G Q (Euclid I. 20). Hence, *à fortiori*, P F, F Q are together greater than P C, C Q. Therefore the sum of P C and C Q is a minimum.

COR.—Join C O, then the angle P C O is equal to the angle Q C O, and we may express the relation deduced above thus:—

The sum of the lines drawn from any point without a circle to a point on the circumference will be a minimum when the two lines are equally inclined to the radius drawn to the last-named point.

The subject of geometrical maxima and minima is a wide one, but we shall content ourselves here by adding three in which areas are dealt with.

Ex. 12.—*Two sides of a triangle being given it is required to construct the triangle so that its area shall be a maximum.*

Let A B, B C, Fig. 20, be the lengths of the given sides.

With centre B and radius B C describe the circle C D F E. Then if we draw any radius B D or B E, and join A D or A E, it is clear that the triangle A B D or A B E thus constructed will have sides A B, B D, or A B, B E of the required length, and it is obvious that the area of any triangle thus formed will be greater or less, according as the distance of its vertex from the line A B C is greater or less. We have not, indeed, any problem in Euclid which

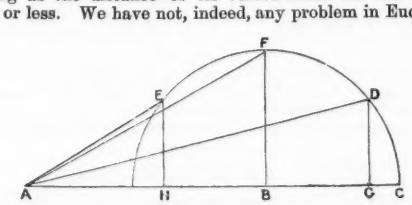


Fig. 20.

expressly states this as a truth respecting triangles on the same base, but the property is clearly involved in the proof of I. 39. Now since the vertex must lie on the circle C D F E, it is obvious that the distance of the vertex from A B C can never exceed the radius of this circle, and can only be equal to the radius when the side adjacent to A B is at right angles to A B. Draw B F at right angles to A B, and join A F. Then the triangle A B F is the triangle of maximum area under the given conditions. The proof consists in showing that D G or E H drawn perpendicular to A B C is less than B F. This is evident; for in the right-angled triangle B D G, the angle D B G is less than a right angle, therefore D G is less than B D; that is, than B F.

Our Chess Column.

By MEPHISTO.

SCORE ON SATURDAY THE 21ST INST. OF THE INTERNATIONAL TOURNAMENT AT NUREMBERG.

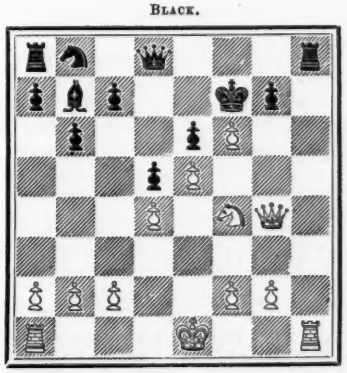
Names.	Bardeleben	Berger	Bier	Bird	Blackburne	Fritz	Gunsberg	Hruby	Lange	Leffmann	Mason	L. Paulsen	W. Paulsen	Riemann	Schallopp	Schottländer	J. Schwarz	Weiss	Winawer	Total score
Bardeleben...	—			½	½		1		1	1		½	1		0	½			0	5½
Berger		—	1	½	½			½		1		½	½	½	½	½	1			5½
Bier.....		0	—	0	0			½				0		0	½		1			2
Bird		½	1	—		½	½		1			1				0	½		0	5
Blackburne..	½	½	1		—				½			½		1	0		1			5
Fritz				½		—			0	½	1	½	1				0		0	3½
Gunsberg ...	0			½			—		0	1	0		1		0		½		1	4
Hruby.....		½	½					—	1			½			0	½	½	½		4
Lange	0			0		1	1		—	1	0			½			0			3½
Leffmann ...	0	0			½	½	0	0	0	—			0					½		1½
Mason						0	1		1		—			½	½	1			0	4
L. Paulsen ...	½	½	1	0	½	½	½					—				½				4
W. Paulsen ..	0	½				0	0		1				—	0	1		½			3
Riemann.....		½	1			0			½		½	1	—			½	0	½		4½
Schallopp ...	1		½		1		1	1			½	0		—			1			6
Schottländer	½	½		1				½			0	½		½	—		0	0	0	3½
J. Schwarz...			0	½	0	1	½	½	1				1			—	½			5
Weiss								½		½			½	½	0	1	½	—	1	3½
Winawer ...	1			1		1	0				1					1		0	—	5

GAME PLAYED IN THE NUREMBERG INTERNATIONAL CHESS TOURNAMENT, JULY 16, 1883.

POSITION after White's 16th move of Q to Kt4:—

MASON.

BLACK.



WHITE.

FRITZ.

French Defence.

WHITE.	BLACK.
16. Q to Kt4	R takes R (ch)
17. K to Q2	P takes P
18. Q to Kt6 (ch)	K to K2
19. Q to Kt7 (ch)	K to K sq
20. Q to Kt8 (ch)	K to K2
21. Q takes P (ch)	K to B sq
22. R takes R	B to B sq

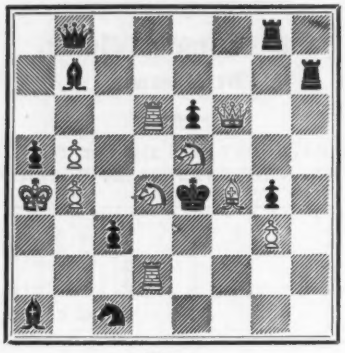
White announced mate in four. 23. R to R8 (ch), K to Kt2. 24. R to R7 (ch), K takes R. 25. Q to B7 (ch), K to R sq. 26. Kt to Kt6 mate.

XUM

FIRST PRIZE THREE-MOVER IN THE PROBLEM TOURNAMENT OF THE GERMAN CHESS ASSOCIATION.

BY FRITZ, OF GEJIERSSTANN.

BLACK.



WHITE.

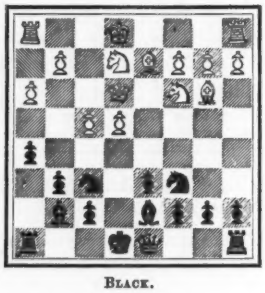
White to play and mate in three moves.

[This is a very beautiful problem. I have ventured to omit the key move, supplied by Mephisto, in the belief that among our Chess readers are many who would prefer to contend with it unaided.—R. P.]

POSITION IN THE GAME BETWEEN PAULSEN AND GUNSBERG.

W. PAULSEN.

WHITE.



BLACK.

GUNSBERG.

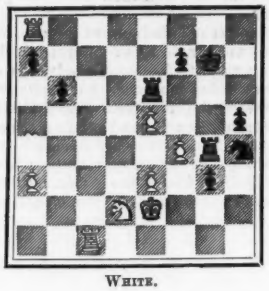
The game proceeded as follows:—

P to K5	P takes P
P takes P	B to R3
Kt to B4	Castles
P takes Kt	R to K sq
Kt to K4	B to B4
Castles QR	R takes Kt
Q to Kt3	Q takes B (ch)
R takes Q	B takes Kt
Q to B2	R to Q sq
R to Q sq	R takes R
R takes R	R to Q5, and won.

POSITION IN THE GAME BETWEEN GUNSBERG AND WINAWER.

WINAWER.

BLACK.



WHITE.

GUNSBERG.

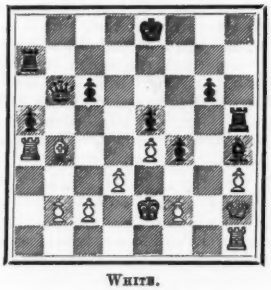
The game proceeded with:—

Kt to B3	Kt takes Kt
K takes Kt	P to Kt7
R (B sq) to B8	R to Kt6 (ch)
K to K4	R (Kt6) takes P (ch)
K to B5	R (K3) takes P (ch)
P takes R	R to B6 (ch)
K to K4	R to K6 (ch)
K to B4, and won.	

POSITION IN THE GAME BETWEEN SCHALLOPP AND GUNSBERG.

SCHALLOPP.

BLACK.



WHITE.

GUNSBERG.

In this position White played as follows:—

KR to QR sq	P to B6 (ch)
K to B sq	QR to KR2
B to Q2	B to B3
R takes P	R takes P
R to R8 (ch)	K to B2
R (R sq) to R7 (ch)	K to K3
Q to Kt sq	R takes R
R takes R	Q takes R
Q to Kt4 (ch)	K to Q3
Q takes R	Q to R8 (ch)
B to K sq	Q to Q8, and wins.

CONTENTS OF No. 90.

	PAGE
A Naturalist's Year. XVII. Crabs and Lobsters. By Grant Allen	33
How to Get Strong: Reducing Fat	34
The Chemistry of Cookery. XIV. By W. Mattieu Williams	35
The Morality of Happiness: Introductory. By Thomas Foster	36
The Birth and Growth of Myth. XI. By Edward Clodd	37
Laws of Brightness. VI. By Richard A. Proctor	38
Are Copper Salts Poisonous?	39
The Fisheries Exhibition. (*Illus*). By John Ernest Ady	40
Flight of a Vertical Missile. By Richard A. Proctor	41
Editorial Gossip	42
The Face of the Sky. By F.R.A.S.	43
Something about the Beet. II.	43
Correspondence: Flight of Missiles —Binocular Vision, &c.	44
Our Mathematical Column: Geometrical Problems. VIII.	46
Our Whist Column	47
Our Chess Column	48

SPECIAL NOTICES.

Part XXI. (July, 1883), just ready, price 10d., post-free, 1s. 1d.

Volume III., comprising the numbers published from January to June, 1883, will be ready in a few days, price 7s. 6d.

The Title Page and Index to Volume III. is now ready, price 2d., post-free, 2½d.

Binding Cases for Volume III., price 2s. each. Subscribers' numbers bound (including Title, Index, and Case) for 3s. each.

The publishers have a few copies of KNOWLEDGE No. 1 at 8d. each, post-free.

TERMS OF SUBSCRIPTION.

The terms of Annual Subscription to the weekly numbers of KNOWLEDGE are as follows:—

	s.	d.
To any address in the United Kingdom	10	10
To the Continent, Australia, New Zealand, South Africa & Canada	13	0
To the United States of America	$3.25. or 13	0
To the East Indies, China, &c. (*viâ* Brindisi)	15	2

All subscriptions are payable in advance.

P. O. Orders and cheques should be made payable to the Publishers, MESSRS. WYMAN & SONS, London, at the High Holborn District Post-office.

Agent for America—C. S. Carter, American Literary Bureau, Tribune Buildings, New York, to whom subscriptions can be forwarded.

OFFICE : 74-76, GREAT QUEEN STREET, LONDON, W.C.